Claims

1. A method of making an ion-conducting composite membrane, the method including:
   (a) combining an electronically and ionically non-conducting polymer, or a blend of at least two such polymers, in solution or in the molten state with low melting point salt; and then
   (b) combining the product obtained from step (a) with hydrolysable organic precursor of silica; and then
   (c) combining the product of step (b) with compatible organic solvent solution of heteropolyacid; and then
   (d) casting, from the product of step (c), a membrane as a film, preferably a thin film.

2. The method of claim 1, including casting said membrane on an inert support.

3. The method of claim 1 or claim 2, including preparing a said blend of two electronically and ionically non-conducting polymers by dissolving each of the polymers separately in common solvent and then mixing the two solutions in such a way as to obtain homogeneous solution of polymer blend.

4. The method of any preceding claim, wherein the step (a) includes incremental addition of low melting point salt into said polymer solution or melt in such a way as to obtain a homogeneous mixture.

5. The method of any preceding claim, wherein the step (b) includes incremental addition to the product of step (a) of hydrolysable precursor of silica in such a way as to obtain a homogeneous mixture.

6. The method of claim 5, wherein the hydrolysable precursor of silica is added

in liquid form.

7. The method of any preceding claim, wherein the step (c) includes incremental addition to the product of step (b) of said heteropolyacid solution in such a way as to obtain a homogeneous liquid solution.

8. The method of any preceding claim, wherein the step (d) includes the use of a moving blade film making machine.

9. The method of any preceding claim, wherein the step (d) includes casting said films with a thickness between 5 and 500 micrometers, preferably on a smooth surface.

10. The method of any preceding claim, wherein the or each polymer is selected from the group consisting of; polysulfone (PS), polyethersulfone (PES), polyphenylsulfone (PPS), polyvinylidenedifluoride (PVdF) or polyimide (PI), and mixtures thereof.

11. The method of any preceding claim, wherein said low melting point salt is water insoluble.

12. The method of claim 11, wherein said water insoluble low melting point salt is selected from the families of imidazolium and pyridinium salts.

13. The method according to claim 12, wherein the low melting point salt selected from said families has a melting point close to room temperature, for example 298 K.

14. The method of any preceding claim, wherein the hydrolysable organic precursor of silica is selected from the family of alkoxysilanes.

15. The method of any preceding claim, wherein the heteropolyacid is selected

from the family of 12-heteropolyacids.

16. An ion-conducting composite membrane (100) comprising ion-conducting channels and a polymer matrix containing silica (106), low melting point salt (108) and Heteropolyacid (HPA).

17. An ion-conducting composite membrane (100) according to claim 16, wherein said ion-conducting channels comprise nano-scale ion-conducting channels.

18. An ion-conducting composite membrane (100) according to claim 16 or claim 17, having a thickness between 5 and 500 micrometers.

19. An ion-conducting composite membrane (100) according to any one of claims 16 to 18, wherein the or each polymer comprises a member of the group consisting of; polysulfone (PS), polyethersulfone (PES), polyphenylsulfone (PPS), polyvinylidenedifluoride (PVdF) or polyimide (PI), and mixtures thereof.

20. An ion-conducting composite membrane (100) according to any one of claims 16 to 19, wherein said low melting point salt comprises a water insoluble low melting point salt, said water insoluble low melting salt preferably comprising a member of the families of imidazolium and pyridinium salts and also preferably having a melting point close to room temperature, for example 298 K.

21. An ion-conducting composite membrane (100) according to any one of claims 16 to 20, wherein the hydrolysable organic precursor of silica comprises a member of the family of alkoxysilanes.

22. An ion-conducting composite membrane (100) according to any one of claims 16 to 21, wherein the heteropolyacid comprises a member of the

family of 12-heteropolyacids.

23. Use of a membrane according to any one of claims 16 to 22 as a proton exchange membrane in a fuel cell.

24. A fuel cell comprising a membrane according to claim 23.